THE EFFECT OF REGIONAL CONFLICTS AND POLITICAL RIVALRIES ON THE RELEASE OF PETROLEUM HYDROCARBONS TO THE ENVIRONMENT

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ABSTRACT

The twentieth century has shown us the economic and social importance of petroleum extraction from the Earth. In almost all of our daily activities, hydrocarbon plays a driving force. Commuting and traveling, building and fixing the house, mowing the lawn, etc., are all feasible with petroleum generated energy. Many of the products that we use are made from petroleum hydrocarbons. Hospital syringes, plastic bags, food containers, computers, etc., are things that are all or partly made with petroleum products and we take them for granted.

Control of petroleum resources has led to long eras of cold wars between nations and in some cases has led to disastrous conflicts. During any regional conflict, the environment is the last thing that the warring sides focus their attention on. The destruction of terrain, crops or the entire ecosystem is a military tactic practiced from ancient times. When large oil fields are shared among two or more countries, there is always a heated rivalry between neighboring countries to extract the maximum possible petroleum from the shared ground. Here, again, the environment falls victim to the abuse of Earth resources. In this article, the environmental damages caused by regional conflicts and political competitions are assesses and discussed. As two contemporary living cases of environmental disasters, the (land and sea) damages of the 1991 Persian Gulf War to the ecosystem and the ecological degradation of the Caspian Sea caused by the competition between the surrounding countries for petroleum extraction are discussed in this article.

Keywords: conflicts, environmental damage, petroleum release, politics

INTRODUCTION

The environment is always the victim of political conflicts and wars. During the Persian Gulf crisis of 1990 to early 1991, the Persian Gulf area experienced overwhelming environmental stress. Over 700 oil wells were destroyed and set on fire by the retreating Iraqi forces from Kuwait in February 1991 [1]. Large quantities of crude petroleum were released into the marine, terrestrial and atmospheric environments. Tidal currents and water mass circulations in the Gulf favoring northwest to southeast and east directions pushed the floating oil pools towards the northern shores of Saudi Arabia and southwestern Gulf States. At least 30,000

marine birds exposed to crude oil were killed. Over 20 per cent of mangroves on the eastern coast of Saudi Arabia and about 50 per cent of the coral reefs were affected by oil contamination. Hundreds of square kilometers of seagrass beds (feeding grounds for dugongs and turtles) as well as tidal mud flats were inundated with heavy petroleum products [2].

Due to the presence of large quantities of unextracted crude oil, Caspian Sea (the World's largest land-locked water body) which lies less than 1000 km north of the Persian Gulf has in recent years become the focal point for economic development of most of the Caspian countries. The Caspian Sea's ecological balance is already facing serious consequences [3] and if neglected, the World may soon face another dead water body similar to the Aral Sea that is located about 400 km northeast of the Caspian Sea in Asia Minor.

In this article the environmental problems related to oil extraction and spills in the Caspian Sea and the 1991 Gulf War impact on Persian Gulf contamination with petroleum products are discussed.

THE CASPIAN SEA CASE STUDY

The Caspian Sea is the largest lake in the world with an area of about 400,000 km^2 (equivalent to the size of Japan) (Figure 1). It is 1,200 km long and 170-450 km wide, and its water volume is 80,000 km^3. The total length of the shoreline is about 7,000 km. The average depth is 180 m and its maximum depth is 1,025 m. All these data are approximate, because they vary considerably depending on the water level of the Sea [4,5]. Morphologically, the Caspian Sea is divided into three main parts, which are more or less equal in area: a very shallow northern part with depths not exceeding 10 m, a middle part with an average depth of 170 m and a maximum depth of 790 m, and the deepest southern part, which has an average depth of 325 m and a maximum depth of 1,025 m [4]. The proportional volumes of the three parts are correspondingly 1/100, 1/3, and 2/3 of the total volume. The salinity of the Caspian Sea water ranges between 0.2 g/liter at the mouth of the Volga River to 12-13 g/liter in the central and southern parts. The northern section has the equivalent of 28% of total surface area and an average depth of 6.2 meters. The direction of either current in this section is clockwise. Central section, covers 36%. The southern section covers the remaining 36%. Water movement direction in the central and southern sections are counterclockwise [4].

Figure 1. Map of the Persian Gulf, the Caspian Sea and Neighboring Countries.
(The Courtesy of World Sites Atlas, Madrid, Spain)
http://www.sitesatlas.com/Maps/Maps/MEast.htm

The level of water in the Caspian Sea is 26 meters below the mean sea level. The water level has demonstrated continuous up and down changes. No clear explanation is available for the reason of these changes. The local people believe that the Caspian Sea water level fluctuation is the results of frequent earthquakes in the area, affecting the structure under the sea. It could be noted here that global warming of the past two decades might have had its share of bringing the Caspian Sea water level higher than its average level recorded in the first eight

decades of the twentieth century. Warmer temperatures may have melted the glaciers located in northern Ural Mountains and northern Russia increasing the water volumes that discharges into the Caspian Sea from the northern rivers. The average water balance of the Caspian Sea from 1900 – 1985 has been tabulated in Table 1.

Table 1. The average water balance of the Caspian Sea, 1900-1985 [4]

Parameter	**km^3/year**
River inflow	+298
Precipitation on the Sea's surface	+74
Evaporation from the Sea's surface	-370
Outflow to the Bay of Kara-Bogaz-Gol	-14
Total	-12

As Table 1 indicates, from 1900 to 1985, there has been a net evaporative loss of 12 km3/year from the Caspian Sea. Since 1978 (The year of Tabas/Khorasan-Iran major earthquake) water level in the Caspian Sea has followed a rising path. Since 1985, the water level of the Caspian Sea has risen 2.5 meters and has flooded many coastal towns in Kazakhstan. At the present time, the level of the water is relatively stable. If water levels continue to rise and one day reach to the normal sea level again, areas as far as St. Pittsburgh in Russia could be flooded. Major rivers discharging into the Caspian Sea are Volga, Ural, Terek, Kuma (flowing through Russia), Sefid Rud, and Atrak (flowing through Iran). Caspian Sea is also an important inland water route. The Caspian occupies an enormous depression and was once linked with the Aral and Black Seas. Much of the land surrounding the sea is covered with a thick layer of yellowish-green clay that was deposited by the sea.

One of the major economic aspects of the Caspian Sea is the fishing industry. Caviar (sturgeon fish eggs) from the Caspian Sea is simply considered one of the most exquisite delicacies in the world. It is completely dependent upon the sea for development and taste.

Petroleum Reserves and Extraction

The local population surrounding the Caspian Sea learned to extract and use oil for domestic purposes in small-scale more than two millennia ago. Large-scale extraction of oil and

gas in the Caspian Sea oil fields started in the middle of 19th century, during which production has had a fluctuating trend. After the disintegration of the former Soviet Union, the newly formed countries of Azerbaijan, Kazakhstan, and Turkmenistan together with Russia and Iran have focused their attention on the oil reserves of the Caspian region [6]. Historical discharge of petroleum by-products and pollutants into the Caspian Sea environment has positioned it in an awkward situation. In terms of pollution discharge ranking Russia stands first, followed by Azerbaijan, Kazakhstan and Turkmenistan. Iran has a small share of polluting the Caspian Sea [3]. However, it should be noted that Iran has not yet conducted any petroleum related drilling and extraction on its Caspian Sea shores and offshore areas. Once these activities start, the possibility of higher pollution discharge into the Caspian Sea will rise significantly.

The petroleum reserves of the Caspian Sea region are detailed in Table 2. The bulk of the petroleum reserves are located in Kazakhstan, Azerbaijan, and Turkmenistan respectively.

Table 2. Petroleum Reserves and Oil Production of the Countries Surrounding the Caspian Sea. (production and export are in 1000 barrels/day) [6].

Country	**Total Reserves**	**Production**	**Exports**	**Major Exporting Cities**
Azerbaijan	31-38 BBL	198.7	42.6	Baku
Iran	12 BBL	0.0	0.0	Neka / Kharg Island
Kazakhstan	95-101 BBL	532.1	254.5	Tengiz/Aktyubinsk/ Atrau
Russia	5 BBL	52.0	0.0	Novorossisk / Terskoye
Turkmenistan	34 BBL	103.9	26.4	Turkmenbashi / Charjou
Uzbekistan	1 BBL	182.6	3.8	-
Total	178 – 191 BBL	1069.3	327.3	-

Geopolitical Aspects of the Caspian Sea

In 1941, during World War II, Hitler wanted to use Caspian oil to fuel his army. He declared that if he failed to seize the Caucasus region, he would be forced to end the war. The defeat for conquering the Caucasus oil came in late 1942 and was the first major setback for Germany. With an estimation of 50 to 200 billion barrels of oil reserves, It is projected that the Caspian Sea is the third largest oil and gas reservoirs of the world [7]. The political changes of the 90s led to diminishing attention that was given to the Caspian Sea environment during the 80s [8].

Ecological Impacts

Commercial oil and gas explorations have taken place in the Caspian Sea for over 150 years. The Volga River and oil drilling works are the two major sources of pollution in the Caspian Sea [8]. Based on published data, petroleum hydrocarbons, phenols, surfactants, and organochlorine pesticides are the priority pollutants entering the Caspian Sea mainly from rivers originating or flowing through Russia.

Scientists estimate that each year an average of 60,000 metric tons of petroleum byproducts, 24,000 tons of sulfites, and 400,000 tons of chlorine are discharged into the Caspian Sea [3]. The present level of contaminants entering the Caspian Sea are threatening the existence of the rare sturgeon and fresh water seals that live there. Since the year 2000, thousands of Caspian seals have died due to pollution that weakened their immune systems. Environmental scientists have warned that poaching of sturgeon and oil prospecting is threatening to push the sturgeon and fresh water seal species into extinction [9].

The deposits of mineral exploration, particularly oil extraction and pipeline construction, have contributed to the pollution of about 30,000 hectares of land [9]. Oil pollution in the Caspian Sea comes from flooded wells (due to rising Sea levels), offshore production, accidental releases of oil, natural seeps, and major rivers [7]. Table 3 lists the estimated total annual oil input to the Caspian Sea.

Table 3. Estimated Total Annual Oil Input to the Caspian Sea [7].

Source	Oil input (tons/year)	Oil input range (tons/year)	Percentage
Seepage and erosion	20,000	10,000 – 50,000	12.5
Oil industry activities	8,000	5,000 – 13,000	5.0
Municipalities	21,000	10,000 – 40,000	13.1
Other industries	35,000	15,000 – 50,000	21.9
Rivers	75,000	50,000 – 260,000	46.9
Atmosphere	1,000	300 – 2,000	0.6
Total	160,000	90,000 – 300,000	100.0

If a comprehensive plan is not set forth for the preservation of natural habitat of the Caspian Sea, there will be no doubt that in near future, sturgeon, caviar, and seals will become past legends and will only exist in science and history text books.

THE PERSIAN GULF CASE STUDY

The Persian Gulf, is a 960-km-long body of water which separates Iran from the Arabian Peninsula, and one of the most strategic waterways in the world due to its importance in world oil transportation. At its narrowest point (the Strait of Hormuz), the Gulf narrows to only 55-km wide (Figure 1).

During the Persian Gulf crisis from 1990 to early 1991, the Persian Gulf area experienced tremendous environmental stress. Over 700 oil wells were destroyed and set on fire by the retreating Iraqi forces from Kuwait in February 1991 [1]. Large quantities of crude petroleum were released into the marine, terrestrial and atmospheric environments. Tidal currents and water mass circulations in the Gulf favoring northwest to southeast and east directions pushed the floating oil pools towards the northern shores of Saudi Arabia and southwestern Gulf States. At least 30,000 marine birds exposed to oil were killed. Over 20 per cent of mangroves on the eastern coast of Saudi Arabia and about 50 per cent of the coral reefs were affected by oil contamination. Hundreds of square kilometers of seagrass beds (feeding grounds for dugongs and turtles) as well as tidal mud flats were inundated with heavy petroleum products [2]. In a study comparing the concentrations of heavy metals in sea sediments among nine major harbors in populous areas of the world, Al-Arefj and Alam (1993) found that the highest concentrations

of heavy metals belonged to northern shores of Saudi Arabia and the Bay of Kuwait following the end of the 1991 Gulf War [11].

Water Currents in the Persian Gulf

The Persian Gulf has an average depth of 35 meters with maximum depths of 110-160 m in current scoured channels near the islands [11]. It is connected to the western Gulf of Oman through the Strait of Hormuz (Figure 1). The evaporation rate is 1.4 m/yr., river runoff is 0.15-0.46 m/yr. and precipitation is 0.07-0.1 m/yr. The high evaporation rate combined with small connection to open oceans has lead to formation of saline, dense water mass known as Persian Gulf Water (PGW) and a reverse estuary circulation through the Strait of Hormuz [11]. Flow of water out of the Gulf is confined to the southern side of the Hormuz channel by geostrophy. The Indian Ocean surface water flows into the Gulf along the northern side of the Strait and continues northward along the Iranian coast. Surface water modeling conducted by Swift and Bower (2003) indicated that the strong, northwest winds in the winter and spring produce southeast flowing surface water. The major rivers flowing into the Persian Gulf have their origins in Iraq and Iran. The Tigris and Euphrates Rivers flow through Mesopotamia (Southeastern Iraq) and join Karoon and Karkheh that flow along the southwestern borders of Iran to form the navigable waterway called the Shat-al-Arab discharging into the northwestern end of the Persian Gulf. The flow of Shat-al-Arab into the Gulf helps in forcing the surface water flow direction towards south and southwest where northern shores of Saudi Arabia are located. High-salinity water flows out of the Persian Gulf into the Gulf of Oman and spreads at 200-350m depth within the Gulf of Oman [11]. The dense (highly saline) water forms during winter in shallow areas of the northern end of the Gulf from January to April.

Environmental Damages to the Persian Gulf

During the first Gulf War, the worst terrestrial damage was incurred on Kuwait and northern shores of Saudi Arabia. As a result of land contamination, ground water aquifers in the area have been severely contaminated and it may take decades before these lands and aquifers are restored to their background conditions. Recent satellite photos show that surface oil spills in Kuwait have virtually disappeared. Examination of topsoil on the ground has shown that dust accumulation over pools of oil have enhanced some growth of vegetation hiding the bulk of oil

spills underneath. The west and southwestern waters and sediments of the Persian Gulf were impacted worse than other areas. The deliberate burning of the oil fields in Kuwait sent 3×10^8 tons of carbon dioxide (~1.5% of the worldwide annual emissions from fossil fuel and biomass burning) into the atmosphere. The smoke plume widths ranged from 15 to 150 km extending as far as 1,000 km. Although local and regional temperatures and solar radiation were reduced beneath the plume, there was not enough evidence to prove that regional climate was consistently affected [2]. Evaporation studies in the Persian Gulf region have indicated that winter evaporations can be as high as double the rate in summer. Therefore, there was rapid evaporation of the oil spill, as it occurred during winter of 1991.

CONCLUSION

The Persian Gulf has been the scene of three major wars in the past two decades. During the Iraq-Iran war that lasted from 1980 to 1988, each side attacked the other's oil tankers causing massive oil spills into the Gulf. In 1991, the Persian Gulf was again the background for another battle known as the 'First Gulf War', as Iraq invaded Kuwait and was subsequently pushed back by allied forces led by the United States. During the First Gulf War, Kuwait oil fields were set on fire by retreating Iraqi forces resulting into irreversible atmospheric deterioration. Many oil tankers were sunk near the shores of Kuwait and Saudi Arabia causing massive oil contamination of the marine environment. During the 'Second Gulf War' that started in March of 2003, the Persian Gulf was again the scene of another major battle.

Less than 1000 km north of the Persian Gulf lies the biggest lake of the world known as the Caspian Sea. In the Caspian Sea, environmental pollutions are not triggered by wars. Political and economical rivalries existing between the countries surrounding the Caspian Sea have accelerated the pace of ecological damages in the region. Being the third (maybe the second) largest oil and gas reservoir of the world after the Persian Gulf Region, the future of the Caspian environment is grim. The Caspian sturgeon and seals are at the brink of becoming extinct and the large population living on the banks of this precious water body are being driven into all kinds of health risks and health hazards. Due to political instability and lack of cooperation between the countries in the Persian Gulf and the Caspian Sea regions, there has not been a comprehensive health study assessing the damages that petroleum spills has caused to the population living near these two water bodies. The future for these two regions does not look

any better than their past. To salvage the fragile habitat of the Persian Gulf and the Caspian Sea, there is a dire need for understanding and cooperation between the countries of these two regions and the United States, which is the dominating power in the area. Without such an understanding, two of the world's unique and precious water bodies will soon plunge into an irreversible environmental catastrophe.

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